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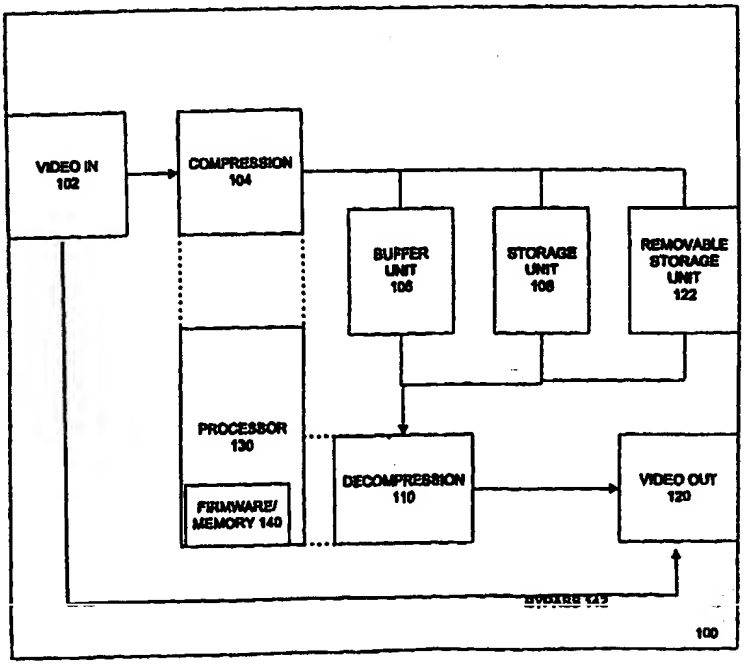
(54) Title: METHOD OF TIME SHIFTING TO SIMULTANEOUSLY RECORD AND PLAY A DATA STREAM

(57) Abstract

A video stream is received at an input (102). The video stream is recorded to a storage unit (108). While the video stream continues to be recorded, a portion of the video stream is retrieved from the storage unit (108) and provided at an output (120). In one embodiment, the storage medium (108) is a random access storage unit, such as a hard disk.



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METHOD OF TIME SHIFTING TO SIMULTANEOUSLY RECORD AND PLAY A DATA STREAM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The described invention relates to the field of imaging. In particular, the invention relates to the recording and playing back of a video stream. A video stream includes any combination of audio and/or video data streams. However, the concepts disclosed may be applied to other types of data streams.

2. Description of Related Art

Video streams have typically been recorded on analog media such as a video cassette. A video cassette recorder (VCR) is used to record the video stream on the video cassette. The video stream may come via a broadcast signal, via cable, via satellite signal, or from another video playback device. Once the video stream has been recorded, the VCR is used to rewind the recording medium and play what was recorded. However, due to the nature of the analog medium, once the VCR has started recording, it is not possible to play back the portion of the video stream that has already been recorded until the recording session is terminated.

For example, imagine that a person sets up a VCR for recording a one hour show because he knows that he will miss the first 15 minutes of the show. When he arrives home 15 minutes into the show, he will have to wait for the entire show to be recorded before he can start watching the program from the beginning. A way of being able to view the show from the beginning without having to wait for the recording session to terminate is desirable.

SUMMARY OF THE INVENTION

A method of providing a time-shifted video stream is disclosed. A video stream is received at an input. The video stream is recorded to a storage unit. While the video stream continues to be recorded, a portion of the video stream is retrieved from the storage unit and provided at an output. In one embodiment, the storage unit is a random access storage unit, such as a hard disk.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a block diagram of a video record and playback system in accordance with one embodiment of the invention.

Figure 2 shows a flowchart of the method of providing a time-shifted video stream.

Figure 3 shows one embodiment of performing block 206 of Figure 2.

Figure 4 shows one embodiment of an apparatus for storing the video stream on a hard disk.

Figure 5 shows an exemplary method of using the storage unit as a temporary buffer.

Figure 6 shows a flowchart of the playback of a video stream catching up to the incoming video stream.

Figure 7 shows another embodiment, in which the user is able to suspend the display of the incoming video stream.

Figure 8 shows an example of a display screen with several image frames taken at different times.

DETAILED DESCRIPTION

The Apparatus

Figure 1 shows a block diagram of a video record and playback system 100 in accordance with one embodiment of the invention. A video stream is received at the VIDEO IN 102. The video stream may be provided by a camera, a television signal, broadcast, cable, or satellite signals, or another video playback device. In one embodiment, the VIDEO IN 102 performs an A to D function that takes analog NTSC signals coming in and decodes the video stream into a digital video bit stream. In a different embodiment, the video is already in digital form. In one embodiment, video record and playback system 100 is a personal computer system, and the VIDEO IN 102 is a video capture card plugged into the personal computer system.

The video stream output of the VIDEO IN 102 is optionally compressed at compression unit 104. In one embodiment, the video is already compressed, such as would be the case with an MPEG2 video signal, and no further compression is needed. The video stream is then stored into storage unit 108. Buffer unit 106 may be used as a temporary storage unit for providing larger sequential blocks of video data to the storage unit 108.

In one embodiment, storage unit 108 is a random access memory unit that allows relatively quick access to any portion of the stored video stream. A hard disk is an example of a random access memory unit. A hard disk

can typically access stored data with access times that are on the order of 10 ms. In contrast, video cassette tapes are mechanically wound to get to a particular point in the video stream.

The video stream is played back by reading the video stream from the storage unit 108. If the video stream was compressed in compression unit 104, then a decompression unit 110 decompresses the retrieved video stream. The video stream is provided to a VIDEO OUT port 120, to which a monitor or other display device is connected to provide sound and/or video to a user.

A removable storage unit 122 may also be included in video record and playback system 100. Examples of removable storage units are a writeable CD ROM, writeable DVD, a flash memory, or another hard disk. The removable storage unit 122 allows a user to transfer a recording of a video stream stored in storage unit 108 to the removable storage unit 122.

In one embodiment, a processor 130 controls the operations of the video record and playback system 100. The compression unit 104 and decompression unit 110 may be implemented in hardware, or the compression and decompression functions of units 104 and 110 may be performed by the processor 130. Processor 130 receives instructions from firmware/memory 140, using technology that is well-known.

Record and Playback Cycle

Figure 2 shows a flowchart of the method of providing a time-shifted video stream. The flowchart begins at block 200, and continues at block 202 at which the video stream is received at an input. The video stream begins being recorded at block 204. At block 206, playback of the video stream that has been recorded is performed by retrieving a portion of the video stream from the random access storage unit while the recording of the incoming video stream continues. The retrieved portion of the video stream is time-shifted from the incoming video stream by a time delay.

At block 208, the portion of the video stream retrieved from the random access storage unit is provided at an output of the video record and playback system 100. The retrieved portion of the video stream can then be displayed by a television or other display device.

By using the method of Figure 2, the record and playback functions are decoupled from one another. The user may now begin watching a recorded TV show from the beginning, i. e., prior to the show being completely recorded.

Figure 3 shows one method for performing block 206 of Figure 2 of retrieving a portion of the video stream from the random access storage unit while continuing to record the incoming video stream. In the disclosed embodiment, the simultaneous recording and playback of the video stream is performed by alternately performing, or multiplexing, one or more stores of the video stream to the random access storage unit with one or more reads of the video stream from the random access storage unit. The multiplexed stores and reads occur quickly enough that the user does not notice an appreciable delay in the playback of the video stream, and none of the incoming video stream is lost, i.e., all of the video stream is recorded. Thus, the record and playback are simultaneous from the user's point of view.

In one embodiment, the random access storage unit is a hard disk. The retrieval of the time-shifted video signal from the hard disk is performed at a first physical location (or sector) of the hard disk, and the storing to the hard disk of the incoming video stream is performed at a different physical location (or sector) on the hard disk. Because it takes more time to jump back and forth between different sectors of the hard disk than the time it takes to read and write to sequential locations in the same sector, data may be buffered to minimize the number of accesses to and from the hard disk using buffer 106. This increases the amount of data transferred per access.

Additionally, because of time constraints for reading and writing to the hard disk, data may be compressed and decompressed to speed transfers to and from the hard disk.

In block 302, the video stream is stored to a random access storage unit. The video stream is optionally compressed and/or buffered prior to storage. In block 304, the video stream retrieved from the random access storage unit. Buffering and/or decompression may be performed before providing the retrieved video stream to the VIDEO OUT port 120.

From block 304, the flowchart proceeds at block 306 which stores the next portion of the video stream in a manner similar to that described in block 302. At block 308, the next portion of the video stream is retrieved in a manner similar to that described in block 304. This process is repeated until either the recording or playback cycle is terminated.

Figure 4 shows one embodiment of an apparatus for storing the video stream in the storage unit 108. In this embodiment, the video stream is stored as separate files 001 to 009 on a hard disk, for example. The

processor 130 keeps track of the file and offset into the file of the data being played back, as well as the file and offset into the file of the data being recorded. If the random access storage unit is fast enough, the more than one video stream can be recorded and played back at the same time.

Temporary buffering (Circular buffering)

Due to the nature of the random access storage unit being capable of easily recording over itself, the random access storage unit may act as a temporary buffer for recording the latest portion, or X number of minutes, of an incoming video stream, where X is set up based upon the size of the storage unit. In one embodiment, X could be set up to be the entire storage unit. As newer portions of the video stream are received, they will overwrite the older portions of the video stream saved in the random access storage unit. In this manner, the temporary buffering of the video stream acts as a circular buffer. In one embodiment, the processor 130 maintains pointers to the beginning and ending points of the temporary buffer. The processor 130 reassigns the pointers as newer portions of the video stream are received and/or older portions of the video stream are overwritten.

Figure 5 shows a flowchart of one method for using the storage unit as a temporary buffer. The flowchart starts at block 500 from which it continues at block 502, at which the video stream is received at an input. Recording of the video stream to the storage unit begins at block 504. At block 506, older portions of the video stream are deleted as newer portions of the video stream are stored to the storage unit.

A user may initiate a playback cycle following block 506. For example, this may occur when the user wishes to re-view a video clip that he just saw. In one embodiment, the user stops recording to the temporary buffer and plays back the last portion of the temporary buffer.

However, it may be more desirable to the user to be able to continue recording as shown at block 508. A record and playback cycle (as described with respect to Figure 2) is started, in which the incoming video stream is recorded while the user re-views the last portion of the temporary buffer. In this manner, after re-viewing the desired video clip, the user can resume sequentially watching the video stream from the point of the video clip.

At block 510, after the record and playback cycle is completed, all or part of the temporary buffer may be saved. Since the temporary buffer store the latest X minutes of the video stream prior to the record and playback

cycle, all or part of the temporary buffer may be allocated to the portion of the video stream saved during the record and playback cycle. Other portions of the video stream may then be deleted from the storage unit, or they may be marked as over-writeable and used as a new temporary buffer.

Playback catching up to Incoming Video Stream

Figure 6 shows a flowchart of a method for playing back of a video stream in a manner that allows it to catch up to the incoming video stream. Usually, during simultaneous playback and recording of the same video stream, the playback of the video stream is time-shifted from the incoming video stream by a time delay. However, if the playback is performed at an overall rate faster than the rate at which the incoming video stream is received, then the playback will catch up to the incoming video stream.

For example, playback of the video stream will have an overall rate faster than the rate of the incoming video stream if the playback is fast forwarded, or if segments of the playback are skipped altogether. When the time delay of the time-shifted video stream being played back falls below a certain threshold, the video and playback system 100 will cease providing the time-shifted video stream from the storage unit. Instead, the incoming video stream will be provided to the VIDEO OUT port 120 directly. In one embodiment, a bypass 142, as shown in Figure 1, allows the incoming video stream to be provided to the VIDEO OUT port 120 directly.

When this happens, the user has caught up to the "live" broadcast, i.e., the incoming video stream. The user may terminate the recording cycle, if he wishes. Alternatively, the user can put the video record and playback system 100 back into the temporary buffering mode in which only the latest portion of the video stream is stored.

"Suspending" Incoming Video Stream

Figure 7 shows another embodiment, in which the user is able to suspend the display of the incoming video stream. This can be used for example, when the user is interrupted, and wishes to continue viewing the video stream after the interruption. When interrupted, the user signals to the video record and playback system 100 to suspend the display of incoming video stream. This can be done via a remote control, for example. At block 702, the video out is suspended. In one embodiment, the VIDEO OUT continues to provide a still image of the image present at the VIDEO OUT when the suspend was encountered.

At block 704 of the flowchart, the incoming video stream is recorded but is not displayed to the monitor. Instead the playback is paused at the point at which the user indicated that the incoming video stream be suspended. When the user is ready to view the video stream again, he can signal the video record and playback system 100 to un-suspend the video stream so that it plays back from the point at which the video stream was suspended, as shown in block 706.

The user may then view the video stream time shifted by the amount of time that he suspended the incoming video stream, or he may fast forward (or rewind) through the time-shifted video stream. When playback of the time-shifted video stream catches up to the point at which the incoming video stream is being recorded, the record and playback system 100 may display the incoming video stream directly from incoming video stream without retrieving the video stream from the storage unit, as described with respect to Figure 6. The recording of the video stream may then be terminated by the user, if desired.

Story Boarding: Fast Forward and Rewind

Employing a random access storage unit for storage of the video stream facilitates jumping to various points within the video stream. One way of jumping is by retrieving different time slices of the video stream. For example, an image frame from the video stream can be retrieved from the storage unit at 1 minute intervals from a current position of the video stream. In one embodiment, an image frame at the current playback position + 1 minute, current playback position + 2 minutes, and so forth are retrieved and displayed on the TV screen.

Figure 8 shows an example of a display screen 800 which displays several image frames taken from the video stream at different times. In Figure 8, the current playback position is designated as X. In one embodiment, the time interval, T, is user programmable. The intervals may be multiples of the time interval, as shown. A small interval may be used if the user wishes to skip a commercial, which usually lasts only a few minutes. Longer intervals such as a half hour may be useful for determining which movies are recorded on a storage unit.

After the image frames are displayed, the user is able to select one of the frames as a new starting point to which to begin an operation, such as a playback or record operation. By using such a story boarding method, it is

easy for a user to quickly jump to a desired location within the video stream.

In one embodiment, the record and playback system 100 is able to detect a black screen or fade out, such as those which accompany the beginning or end of a commercial. This is useful in editing a video stream.

Editing

Having the video stream stored on a random access storage unit such as a hard disk allows for easy editing of the video stream. Individual frames of the video stream may be deleted or replaced. For example, a commercial may be replaced by a fade-to-black sequence.

Once the video stream on the storage unit has been edited, it can be stored to a more permanent medium such as a writeable CD-ROM, flash memory, or another hard disk via the removable storage unit 122.

Conclusion

Thus, a method of simultaneously recording and playing back a time-shifted video stream is disclosed. The specific arrangements and methods described herein are merely illustrative of the principles of this invention. For example, the same method may be used to store and retrieve other types of data streams besides video streams. Numerous modifications in form and detail may be made without departing from the scope of the described invention. Although this invention has been shown in relation to a particular embodiment, it should not be considered so limited. Rather, the described invention is limited only by the scope of the appended claims.

CLAIMS

WHAT IS CLAIMED IS:

1. A method of displaying a video stream comprising the steps of:
(a) receiving a video stream at an input;
(b) recording the video stream to a storage unit;
(c) retrieving a portion of the video stream from the storage unit while continuing to record the video stream in the step (b); and
(d) providing at an output the portion of the video stream retrieved in the step (c).

2. The method of claim 1 wherein the step (b) is further comprised of recording the video stream to a hard disk.

3. The method of claim 1 wherein the step (b) is further comprised of recording the video stream to a random access media.

4. The method of claim 1 wherein the step (c) of retrieving the portion of the video stream retrieves the video stream recorded in the step (b) time shifted by a time delay, and wherein when the time delay falls below a predetermined threshold, the step (c) of retrieving a portion of the video stream from the storage unit is discontinued, and the step (d) of providing at an output the portion of the video stream retrieved in the step (c) is substituted by the step of providing at an output the video stream as it is received in the step (a).

5. The method of claim 1 further comprising the step of:
(e) retrieving two or more frames of the video stream shifted by different time delays;
(f) displaying the two or more frames of the video stream; and
(g) allowing a user to select one of the frames of the video stream as a starting point for playing back the video stream.

6. A method of displaying a video stream comprising the steps of:
(a) receiving the video stream at an input;
(b) initiating one or more stores of the video stream into a storage unit;

(c) initiating one or more reads of the video stream from the storage unit, wherein the one or more stores of the step (b) are multiplexed with the one or more reads of the step (c); and
(d) displaying the video stream.

7. The method of claim 6 wherein the one or more reads of the video stream from the storage unit are used to play back the video stream at a rate faster than it is being stored in the step (b).

8. The method of claim 6 wherein the one or more reads of the step (c) correspond to the video stream of the step (a) shifted by a time delay, wherein when the time delay falls below a predetermined amount of time, the one or more reads from the storage unit cease, and the step (d) is further comprised of the step of:
(d) displaying the video stream received in the step (a).

9. The method of claim 6 wherein the one or more reads of the step (c) access the video stream offset by a time delay from the video stream being stored in the step (b), the time delay being variable over time.

10. The method of claim 6 further comprising the step of:
(e) retrieving two or more frames of the video stream shifted by different time delays;
(f) displaying the two or more frames of the video stream; and
(g) allowing a user to select one of the frames of the video stream as a starting point for playing back the video stream.

11. A method of displaying a video stream, the method comprising the steps of:
(a) receiving the video stream;
(b) storing the video stream received in the step (a) to a storage unit; and
(c) displaying the video stream at least initially delayed by a time delay, wherein when the time delay is greater than a predetermined threshold the video stream is displayed from the storage unit, and wherein when the time delay is less than the predetermined threshold the video stream is displayed from the video stream received in the step (a).

12. The method of claim 11, wherein the step (b) of storing the video stream to the storage unit comprises performing one or more stores to the storage unit, and the step (c) of retrieving the video stream from the storage unit when the time delay is greater than the predetermined threshold comprises performing one or more reads from the storage unit, and the one or more stores to the storage unit are multiplexed with the one or more reads from the storage unit.

13. The method of claim 12, wherein the storage unit is a random access memory unit, and the one or more reads from the storage unit retrieve the video stream with one or more time delays that are user-specified.

14. The method of claim 11, wherein the step (b) of storing the video stream to the storage unit further comprises compressing the video stream prior to storing the video stream to the storage unit.

15. The method of claim 11, wherein the step (c) of retrieving the video stream from the storage unit when the time delay is greater than the predetermined threshold comprises decompressing the video stream after retrieving the video stream from the storage unit.

16. A method of recording a video stream, the method comprising the steps of:
(a) receiving the video stream;
(b) initiating storing the video stream in a storage unit;
(c) deleting older portions of the video stream from the storage unit as new portions of the video stream are stored to the storage unit;
(d) receiving a user input designating a start of a record cycle; and
(e) storing the video stream received after the start of the record cycle.

17. The method of claim 16 further comprising the steps of:
(f) maintaining at least a portion of the video stream prior to the record cycle.

18. A method of recording a video stream, the method comprising the steps of:
(a) receiving the video stream;
(b) displaying the video stream as it is received;

(c) responsive to a first user input, suspending display of the video stream and storing to a storage medium the video stream received subsequent to the first user input.

19. The method of claim 18 further comprising:
(d) responsive to a second user input, reading the video stream from the storage medium, and providing the video stream at an output while continuing to record the video stream as it is received.

20. The method of claim 19 wherein reading the video stream from the storage medium in the step (d) is performed at an overall rate faster than a rate that the video stream is being received.

21. The method of claim 20 wherein reading the video stream from the storage medium is performed by skipping portions of the video stream.

22. The method of claim 19 wherein the step (d) is further comprised of:
(d) reading the video stream from the storage medium to provide the video stream at the output.

23. The method of claim 22 wherein the video stream read in the step (d) corresponds to the video stream received in the step (a) shifted by a time delay, wherein when the time delay falls below a predetermined amount of time, the method further comprising the step of:
(e) providing at an output the video stream received in the step (a) without first storing the video stream to the storage medium.

24. The method of claim 19 further comprising the step of:
(e) retrieving two or more frames of the video stream shifted by different time delays;
(f) displaying the two or more frames of the video stream; and
(g) allowing a user to select one of the frames of the video stream as a starting point for playing back the video stream.

25. A method of recording a video stream, the method comprising the steps of:
(a) receiving the video stream;

(b) storing the video stream into a temporary buffer, wherein older portions of the video stream are continually updated by new portions of the video stream; and

(c) responsive to a user input, displaying a portion of the video stream stored in the temporary buffer.

FIG. 1

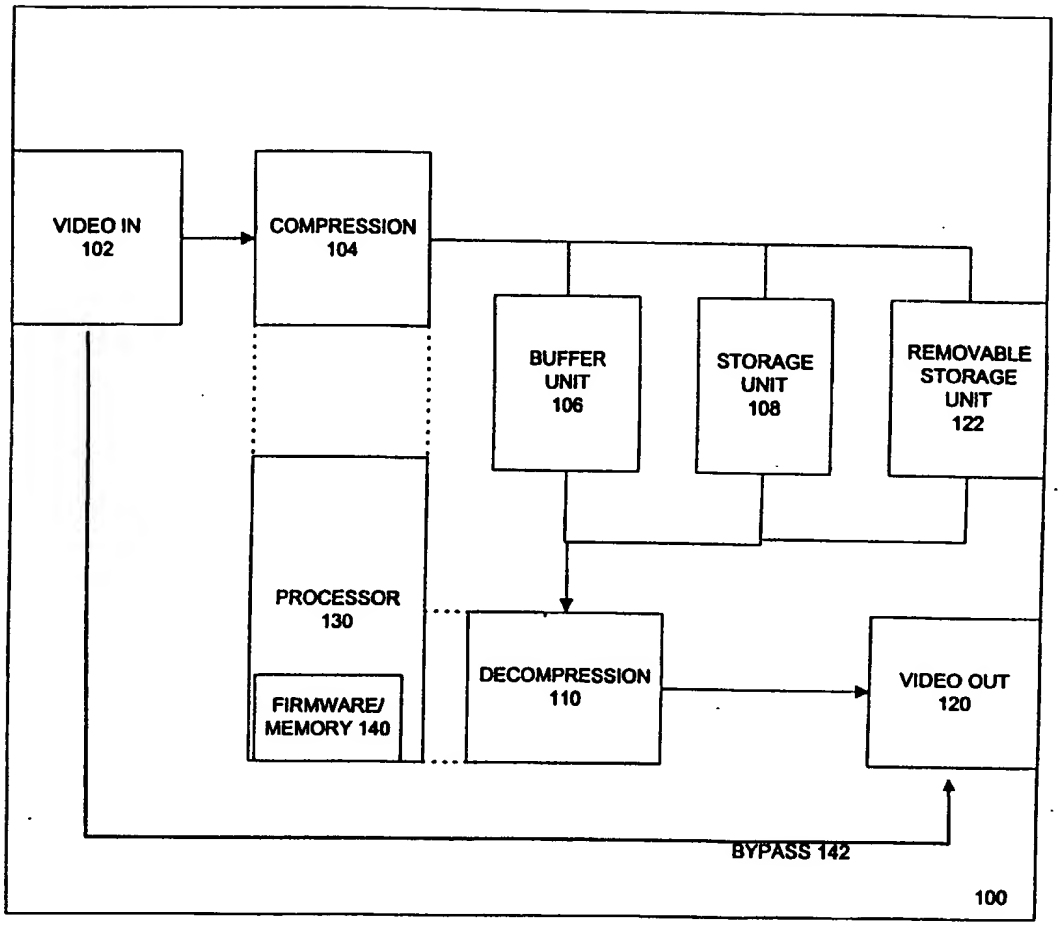

VIDEO IN
102
COMPRESSION
104
BUFFER
UNIT
106
STORAGE
UNIT
108
REMOVABLE
STORAGE
UNIT
122
PROCESSOR
130
FIRMWARE/
MEMORY 140
DECOMPRESSION
110
VIDEO OUT
120
BYPASS 142
100

FIG. 2

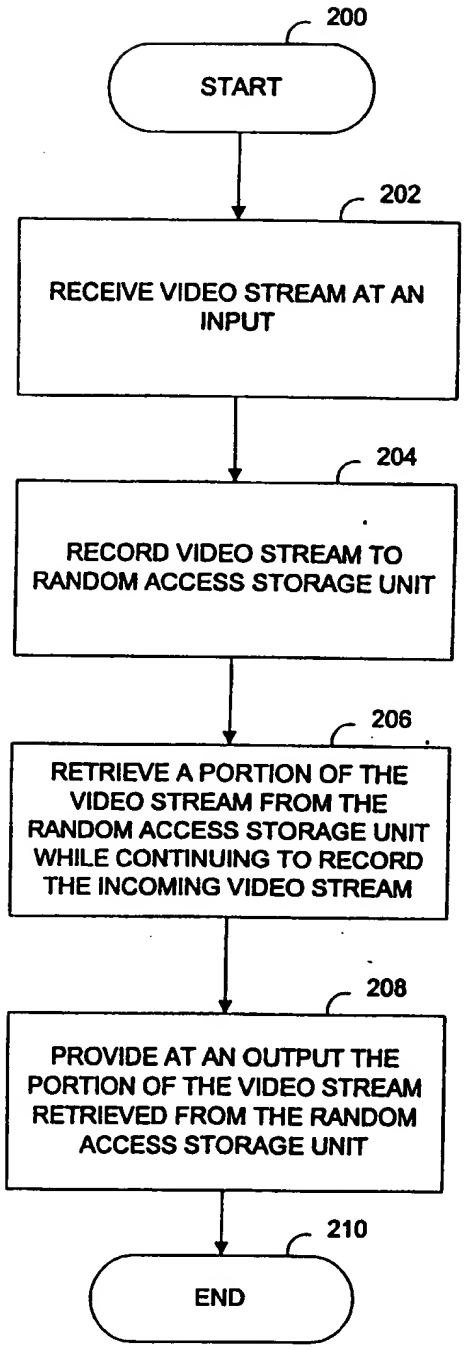

200
START
202
RECEIVE VIDEO STREAM AT AN INPUT
204
RECORD VIDEO STREAM TO RANDOM ACCESS STORAGE UNIT
206
RETRIEVE A PORTION OF THE VIDEO STREAM FROM THE RANDOM ACCESS STORAGE UNIT WHILE CONTINUING TO RECORD THE INCOMING VIDEO STREAM
208
PROVIDE AT AN OUTPUT THE PORTION OF THE VIDEO STREAM RETRIEVED FROM THE RANDOM ACCESS STORAGE UNIT
210
END

FIG. 3

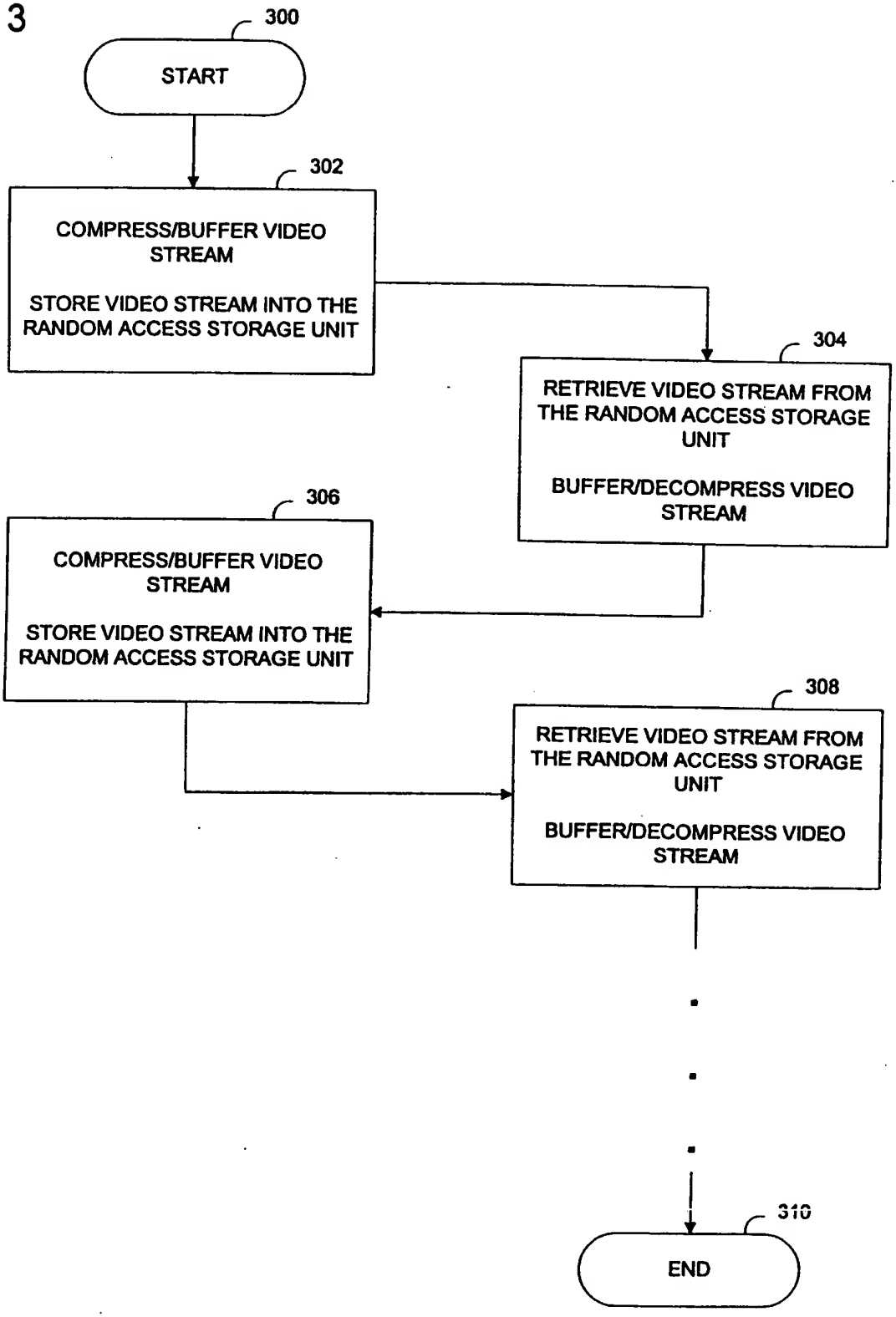
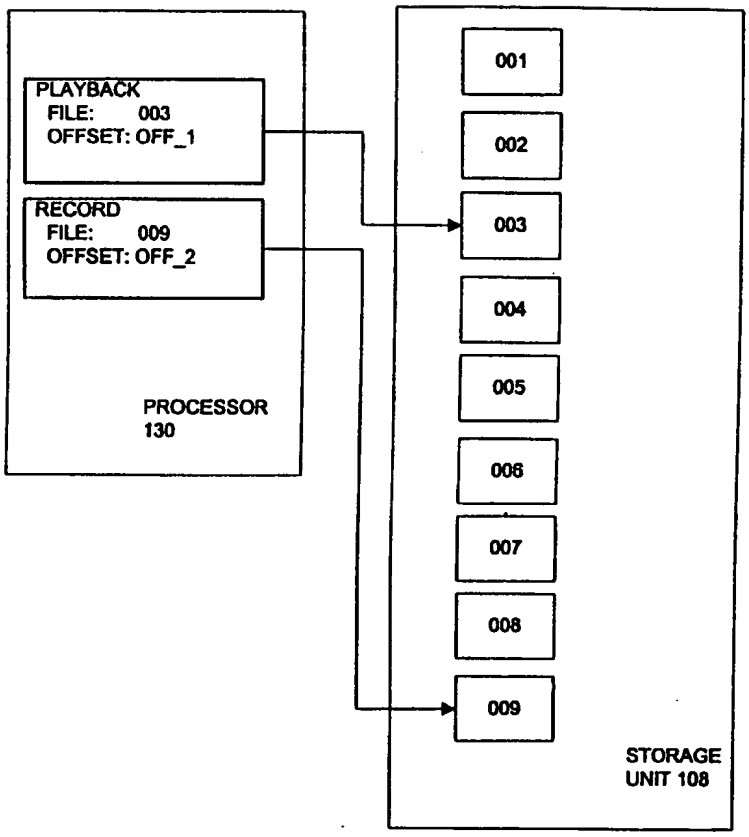

300
START
302
COMPRESS/BUFFER VIDEO STREAM
STORE VIDEO STREAM INTO THE RANDOM ACCESS STORAGE UNIT
304
RETRIEVE VIDEO STREAM FROM THE RANDOM ACCESS STORAGE UNIT
BUFFER/DECOMPRESS VIDEO STREAM
306
COMPRESS/BUFFER VIDEO STREAM
STORE VIDEO STREAM INTO THE RANDOM ACCESS STORAGE UNIT
308
RETRIEVE VIDEO STREAM FROM THE RANDOM ACCESS STORAGE UNIT
BUFFER/DECOMPRESS VIDEO STREAM
310
END

FIG. 4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003
004
005
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STORAGE
UNIT 108

FIG. 5

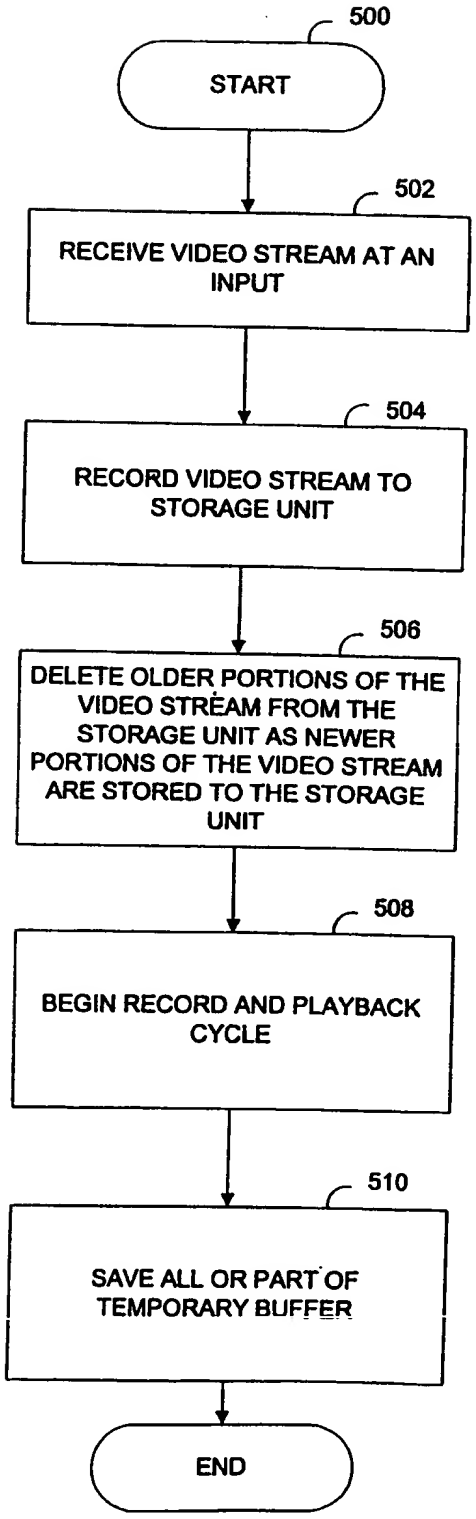

500
START
502
RECEIVE VIDEO STREAM AT AN INPUT
504
RECORD VIDEO STREAM TO STORAGE UNIT
506
DELETE OLDER PORTIONS OF THE VIDEO STREAM FROM THE STORAGE UNIT AS NEWER PORTIONS OF THE VIDEO STREAM ARE STORED TO THE STORAGE UNIT
508
BEGIN RECORD AND PLAYBACK CYCLE
510
SAVE ALL OR PART OF TEMPORARY BUFFER
END

FIG. 6

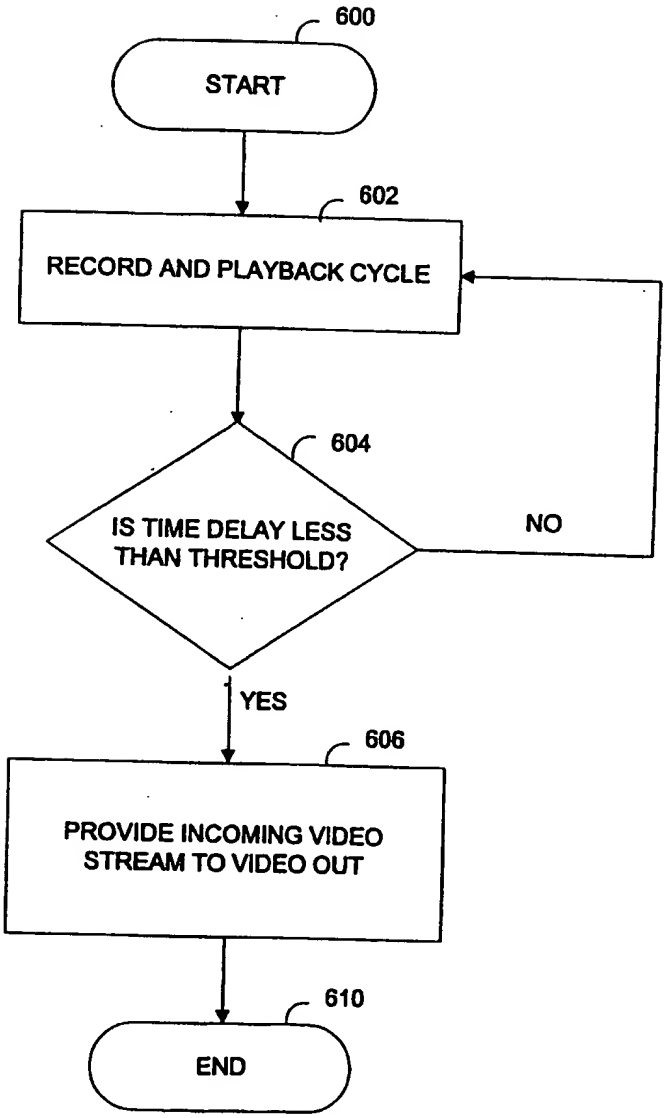

600
START
602
RECORD AND PLAYBACK CYCLE
604
IS TIME DELAY LESS THAN THRESHOLD?
NO
YES
606
PROVIDE INCOMING VIDEO STREAM TO VIDEO OUT
610
END

FIG. 7

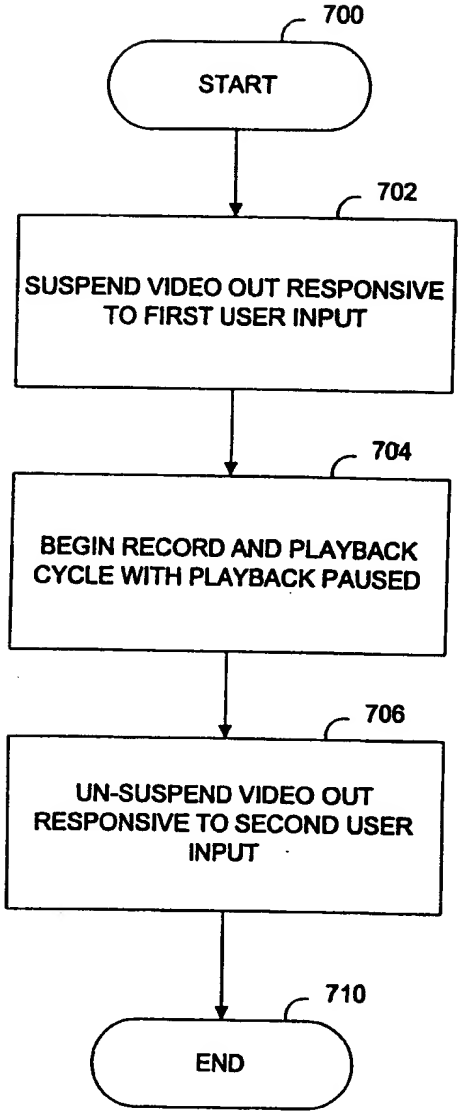
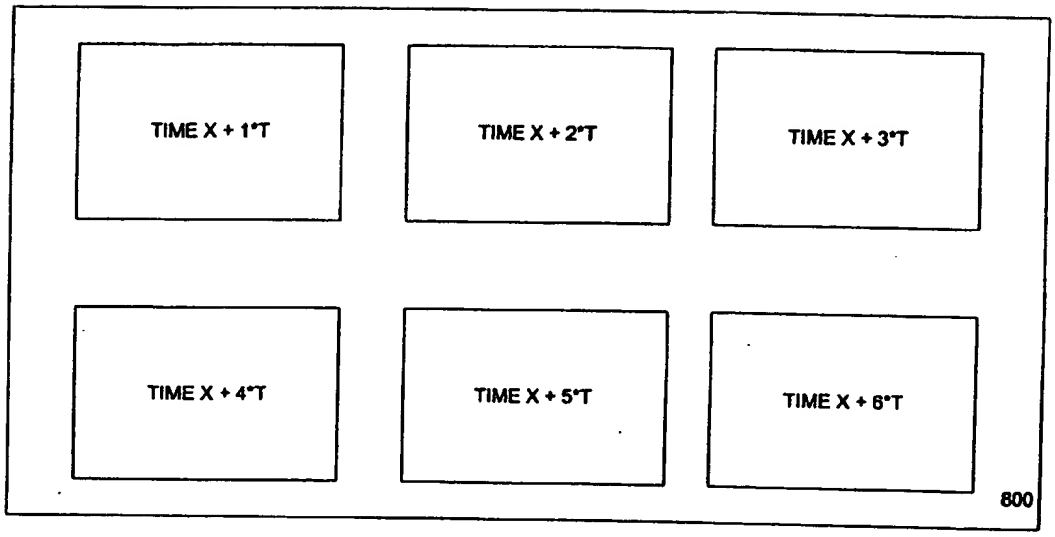

700
START
702
SUSPEND VIDEO OUT RESPONSIVE TO FIRST USER INPUT
704
BEGIN RECORD AND PLAYBACK CYCLE WITH PLAYBACK PAUSED
706
UN-SUSPEND VIDEO OUT RESPONSIVE TO SECOND USER INPUT
710
END

FIG. 8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/22599

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04N 5/91
US CL :386/83

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 386/83, 46, 1, 52, 92, 4, 40, 124

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,479,302 A (HAINES) 26 DECEMBER 1995, COL. 4, LINE 51, TO COL. 40	1-3, 5-7, 9-10, 16-22, 24-25

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
31 JANUARY 1999	07 APR 1999
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer ROBERT CHEVALIER Telephone No. (703) 305-4780

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